J.R.Schrieffer, 1964, Theory of Superconductivity

Koji Higasa

2020 年吉日

Preface

これは [1] の計算を追ったものである.

目次

第 1 章 Introduction 7
1.1 Simple Experimental Facts 7
1.2 Phenomenological Theories 7

第 2 章 The Pairing Theory of Superconductivity 9
2.1 Physical Nature of the Superconducting State 9
2.2 The One-Pair Problem 9
2.3 Landau's Theory of a Fermi Liquid 9
2.4 The Pairing Approximation 9
2.5 Quasi-Particle Excitations 9
2.6 Linearized Equations of Motion 9

第 1 章

Introduction

1.1 Simple Experimental Facts

1.2 Phenomenological Theories

1.2.1 Gorter-Casimir Model

(1-6).

$$
\begin{aligned}
\frac{\partial F}{\partial x} = \frac{1}{2}\frac{1}{\sqrt{x}}\left(-\frac{1}{2}\gamma T^2\right) - 1(-\beta) &= 0 \\
\frac{\gamma T^2}{4}\frac{1}{\sqrt{x}} &= \beta \\
\therefore \sqrt{x} &= \frac{\gamma T^2}{4\beta} \\
\therefore x &= \left(\frac{\gamma}{4\beta}\right)^2 T^4
\end{aligned}
$$

(1-8).

$$
\begin{aligned}
H_c^2(T) &= 8\pi(F_n(T) - F_s(T)) = 8\pi(F(1,T) - F(0,T)) \\
&= 8\pi(f_n(T) - f_s(T)) = 8\pi\left(-\frac{1}{2}\gamma T^2 + \beta\right) \\
&= 8\pi\beta\left(1 - \frac{\gamma}{2\beta}T^2\right) \equiv H_0\left(1 - \left(\frac{T}{T_c}\right)^2\right)
\end{aligned}
$$

(1-9).

$$
\begin{aligned}
C_{es}(T) &= -T\left(\frac{\partial^2 F}{\partial T^2}\right) = -T\sqrt{x}(-\gamma) = \gamma T\sqrt{x} \\
&= \gamma T_c\left(\frac{T}{T_c}\right)^3 \because \text{Eq.(1-6)}
\end{aligned}
$$

1.2.2 The London Theory

1.2.3 F.London's Justification of the London Theory

1.2.4 Pippard's Nonlocal Generalization of the London Theory

1.2.5 Ginsburg-Landau Theory

(1-43).

$$
\begin{aligned}
f(T) &= a\left(-\frac{a}{b}\right) + \frac{1}{2}b\left(-\frac{a}{b}\right)^2 \\
&= -\frac{a^2}{b} + \frac{a^2}{2b} = -\frac{a^2(T)}{2b(T)}
\end{aligned}
$$

(1-44).

$$
\begin{aligned}
\frac{\lambda^2(0)}{\lambda^2(T)} &= \frac{n_s^2(T)}{n_s^2(0)} = \frac{|\Psi_e(T)|^2}{|\Psi_e(0)|^2} \because \text{Eq.(1-38)} \\
&= |\Psi_e(T)|^2 \because n = n_s \quad \text{for} \quad T = 0 \\
\therefore& |\Psi_e(0)| = 1
\end{aligned}
$$

(1-48).

$$
\begin{aligned}
&\frac{\partial f}{\partial \Psi(\mathbf{r})} = 0 \\
\Rightarrow\ &0 = -\frac{\hbar^2}{2m^*}\left(\nabla + \frac{\mathrm{i}e^*}{\hbar c}A(\mathbf{r})\right)2\Psi(\mathbf{r}) \\
&0 = -\frac{H_c^2(T)}{4\pi m^*}\frac{\lambda^2(T)}{\lambda^2(0)}\left(1 - \frac{\lambda^2(T)}{\lambda^2(0)}|\Psi(\mathbf{r})|^2\right)2\Psi(\mathbf{r}) \\
&\therefore \text{Eq.(1-48)}
\end{aligned}
$$

(1-51).

(1-52).

第 2 章

The Pairing Theory of Superconductivity

2.1 Physical Nature of the Superconducting State

2.2 The One-Pair Problem

2.3 Landau's Theory of a Fermi Liquid

2.4 The Pairing Approximation

2.5 Quasi-Particle Excitations

2.6 Linearized Equations of Motion

参考文献

[1] J.R.Schrieffer. 1964. Theory of Superconductivity [Revised Printing]. http://zimp.zju.edu.cn/~qchen/Teaching/AdvStat/Schrieffer.pdf